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Climate of the Past Discussions

Interactive comment on "Historical and idealized climate model experiments: an EMIC intercomparison" *by* M. Eby et al.

Anonymous Referee #1

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The paper by Eby and co-authors is an impressive work aiming at addressing key issues concerning historical climate and carbon cycle changes over the last millennium. Many appropriate and specific sensitivity studies were dedicated to evaluate model's standard characteristics, the individual and summed influence of external natural forcings vs the influence of initial state on global temperatures and climate-carbon feedbacks over the last millennium as compared to model internal climate variability. They used a variety of EMICS to address the possible model dependency of each results and extract the robust signal. Even though the paper is well written and the authors tried to be concise, I think more work is still needed to address the outstanding questions raised by the authors.

If the authors want to evaluate the relative contributions of the applied natural exter-

nal forcings they should at least be more specific and give more information on the forcing data set used and how they were applied. Obviously due to EMICS inherent simplified physics and their coarse resolution, external solar and volcanic forcings will merely be applied as anomaly to the solar constant, while tropospheric aerosols as anomalies to the surface albedo. But by doing so, several additional assumptions and uncertainties might be added and these should be presented and discussed as most of the following results and conclusions concerning temperature and carbon cycle responses will directly depend on these assumptions. In that sense, it is quite misleading to specifically write in the text, that "sulphate and volcanic aerosols" were included in the models to run the simulations since it is actually not the case. No information is given in the paper on how these forcings were diagnosed, parameterised in the EMICS and evaluated against observational dataset over the instrumental period for the tropospheric sulphate aerosol for example or even for the volcanic aerosols. Figure 7 is limited to 250 years while in figure 10, the most striking feature that stems out of the simulations with and without free CO2 are cooling excursions far more important than the MCA/LIA differences. How realistic are these cooling events as compared to temperature reconstructions and how do they impact the conclusion concerning the role of land and ocean carbon fluxes on atmospheric CO2? The authors' main conclusion and discussion concern the underestimation of temperature drop between the MCA/LIA while ignoring most important cooling periods preceding LIA. From the figure 10a and 10b, this doesn't look like a cooling trend at all, but rather like a succession of cooling cycles of more or less the same amplitude. The realism of these cooling cycles need to be evaluated respectively to the discussion on MCA/LIA amplitude anomaly, which definition referring to Franck et al (2010), is not meaningful is this context. Without such discussions and analyses, we can't judge if the related impact on the carbon cycle is relevant, as compared to other studies such that of Junclaus et al 2010. How these results do compare to other GCM studies? What are the differences and added values/information of the present EMICS study respectively to other recent studies addressing the same questions? These need to be discussed and authors have also

to take into consideration all recently published modeling work addressing the same issues.

The authors should also provide at least a figure showing time series of each applied external forcings in each models, in W/m2, so the reader can have an idea of eventual trends and relative amplitude of anomalies existing in the applied forcings in each model. This is very important piece of information when discussing the supposedly linear response of surface temperature to individual forcing, possible errors in these forcings, the role of initial state on the following climate/carbon responses for the last 1000 years as compared to paleoclimate reconstructions. All theses issues need to be carefully considered before accepting the manuscript for publication.

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